cludes interesting sections on inorganic and organic nomenclature. Many American chemists should read and heed the translating rules contained in these sections, for all too often German spellings, especially endings, are carried over into names used as English. At times this results in confusion. The new dictionary will tend to correct this bad practise, and it is hoped that it will help the cause of good chemical nomenclature in other ways.

Besides words from fields of science related to chemistry the dictionary contains a general vocabulary "to save the user the trouble of looking up the more common German words in a separate dictionary" and "because many general words have a technical, or at least a customary, chemical meaning," which "in a general work is often either absent or buried among other senses." The entries are all brief, few of them requiring more than a single line (two columns to the page). There are no long paragraphs of combinations, examples, etc., to wade through. The English equivalent usually sought by the scientist is given at once. These features add greatly to the convenience in use.

The use of small type (six point), which does not seem objectionable since one does not read a dictionary steadily, has made for compactness. The book will fit a large pocket. The work of the printer and binder (the cover is flexible) has been well done.

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## SPECIAL ARTICLES

### THE NATURE OF THE ULTIMATE MAGNETIC PARTICLE

IT appears probable from various considerations that when a substance is magnetically saturated, the "molecular magnets" of which it is composed have their axes arranged parallel with the external magnetic field. On this assumption it is possible to investigate the validity of those theories, such as Bohr's which would explain the magnetic properties of an atom as due to electrons revolving about the atomic center in orbits all lying in the same plane.

It has been shown that the relative intensity of the different orders of an X-ray spectrum line depends upon the distance of the electrons from the middle planes of the atomic layers in the diffracting crystal.[1] Imagine X-rays to be reflected from the surface of a ferro-magnetic crystal composed of atoms of the type just described. When the crystal is unmagnetized the different atoms will have their electronic orbits distributed in all possible planes, so that on the average the electrons will be at an appreciable distance from the mid-planes of their atomic layers. If, however, the crystal is magnetically saturated perpendicular to the reflecting face of the crystal, the electronic orbits, being perpendicular to the magnetic axes of their atoms, will all lie parallel to the crystal face. The electrons will therefore now be *in* the mid-planes of the layers of atoms which are effective in producing the reflected beam. It can be shown that such a shift of the electrons must produce a very considerable increase in the intensity of the reflected beam of X-rays. On the other hand, if the crystal is magnetized parallel to the reflecting face, the turning of the orbits will carry the electrons farther, on the average, from the middle of their atomic layers, and a decrease in the intensity of reflection should result. Of course if the electrons are arranged isotropically in the atom, or if the atom is not rotated by a magnetic field, which would mean that it is the electron or the positive nucleus that is the ultimate magnetic particle, no such effect should be observed.

We have hunted in vain for such an effect on the intensity of the reflected beam of X-rays when the reflecting crystal is strongly magnetized. In our experiment a "null method" was employed. The ionization due to the beam of X-rays reflected from a crystal of magnetite was balanced against that due to a beam reflected from a crystal of rock-salt, so that a very small change in the relative intensity of either beam could be detected, while variations in the X-ray tube itself had little effect.

[1] A. H. Compton, *Phys. Rev.*, 9, 29 (1917).

By means of an electromagnet with a laminated core the magnetite crystal was magnetically saturated, and then demagnetized with an alternating current. The effect of magnetization perpendicular to the plane of the crystal face was investigated for the first four orders. On account of mechanical difficulties the test was made only in the third order when the crystal was magnetized parallel to the reflecting surface. In no case was any change observed in the intensity of the reflected beam when the crystal was magnetized or demagnetized, though the method was sufficiently sensitive to detect a variation in the intensity of less than 1 per cent.

A direct calculation shows that a displacement of the atoms of 0.004 of the distance between the successive atomic layers is sufficient to cause 1 per cent. change in the intensity of the fourth order spectrum. If there is any displacement of the atoms when a crystal is magnetized, it is therefore very small. This confirms the observation of K. T. Compton and E. A. Trousdale[2] that magnetization does not shift the atoms in a crystal sufficiently to change the general form of the space lattice in which they are arranged, and verifies their conclusion that the ultimate magnetic particle is not a group of atoms, such as the chemical molecule, but is the individual atom or something within the atom.

It can be shown further that if all the electrons in an atom are in the same plane, the effect on the intensity of the reflected X-ray beam of turning the atom will be greater than one per cent. unless the effective radius of the atom is less than $10^{-10}$ cm. Other considerations, however, prove that the radius of the atom must be much greater than this.

There is a relatively small number (26) of electrons in the iron atom, and it appears probable that 8 of these, as valence electrons, are at a considerably greater distance than the others from the center of the atom. It is therefore difficult, though perhaps not impossible, to imagine an arrangement of the electrons so isotropic that a rotation of the atom will not produce an appreciable change in the intensity of the reflected X-ray beam.

[2] K. T. Compton and E. A. Trousdale, *Phys. Rev.*, 5, 315 (1915).

The most obvious explanation of our negative result is that it is not the atom which is the elementary magnet, but that it is either the positive nucleus, as suggested by Merritt, or the electron, as suggested by Parson.

If the ultimate magnetic particle is not rotated to any great extent by the magnetic field, no conclusions can be drawn from our experiments. It appears much more probable however, that the molecular magnet is capable of being turned through a large angle, and on this basis we may conclude that:

1. The ultimate magnetic particle is either the atom or something within the atom.
2. If the atom is the ultimate magnet, its electrons are not all distributed in the same plane, as assumed by Bohr, but are arranged very nearly isotropically.
3. Our experiments are in accordance with the hypotheses that the atomic nuclei or the electrons themselves are the ultimate magnetic particles.

In a subsequent paper we shall describe our experiment in greater detail, and shall discuss more fully the significance of our negative result.

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## APPARATUS FOR PHYSIOLOGICAL AND PHYSICAL LABORATORIES

*An Adjustable Stand for Graphic Experiments.*—The stand illustrated in the figure was designed by me, twenty-three years ago, for use with the piston-recorder for air transmission. It has served its purpose so admirably, and is so well adapted for all graphic work where a very delicate adjustment of the writing point is required, that it has seemed to merit a description in print.

The features that have commended it especially are its simplicity, its great delicacy of movement and absence of backlash, and the ability to use it at all times for any of the purposes for which a small stand is necessary.

Its construction is not difficult, but requires accurate workmanship.